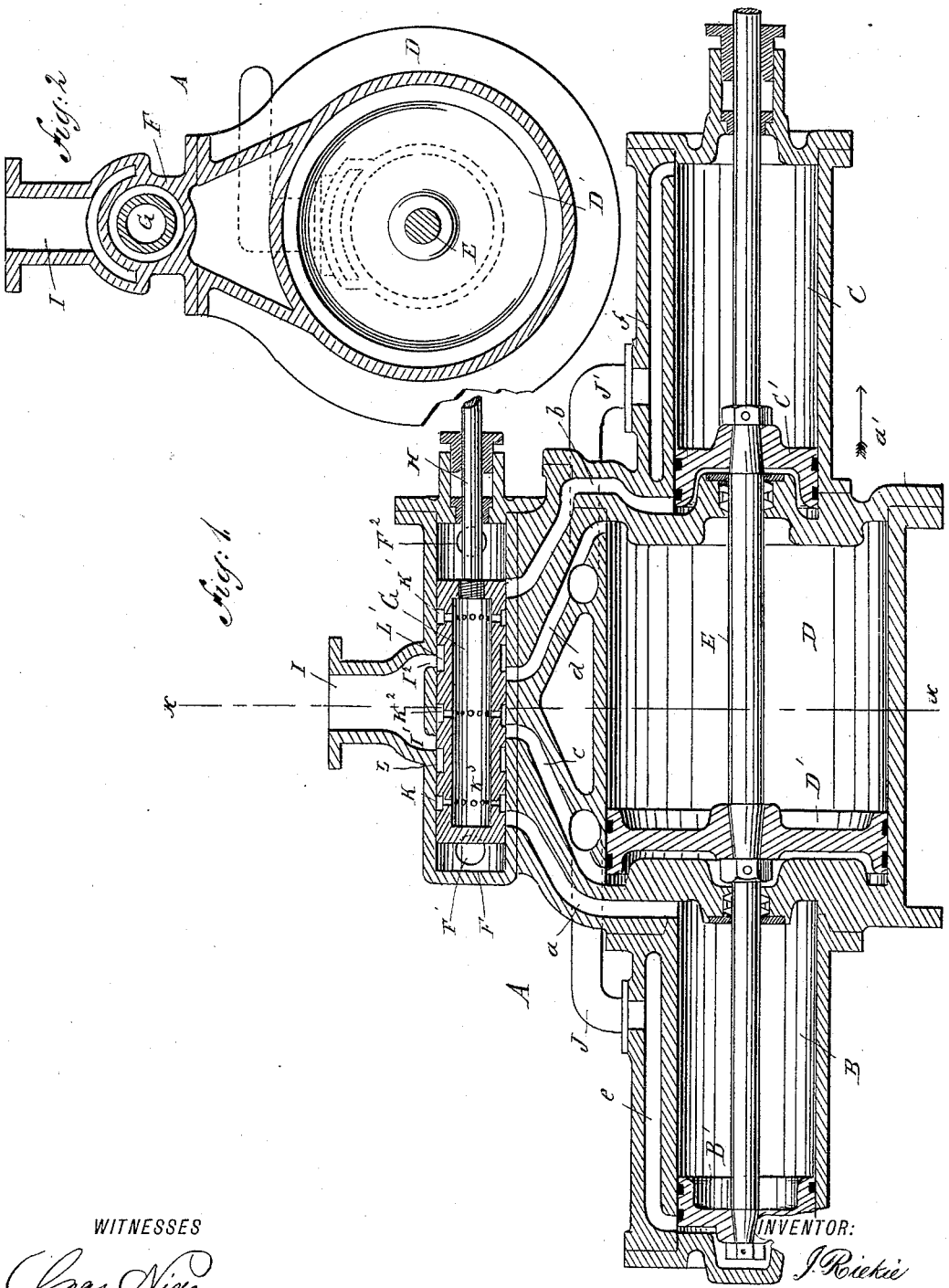
(No Model.) 2 Sheets—Sheet 1.

J. RIEKIE.

COMPOUND ENGINE.

No. 422,157. Patented Feb. 25, 1890.



WITNESSES

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Fig: 3.

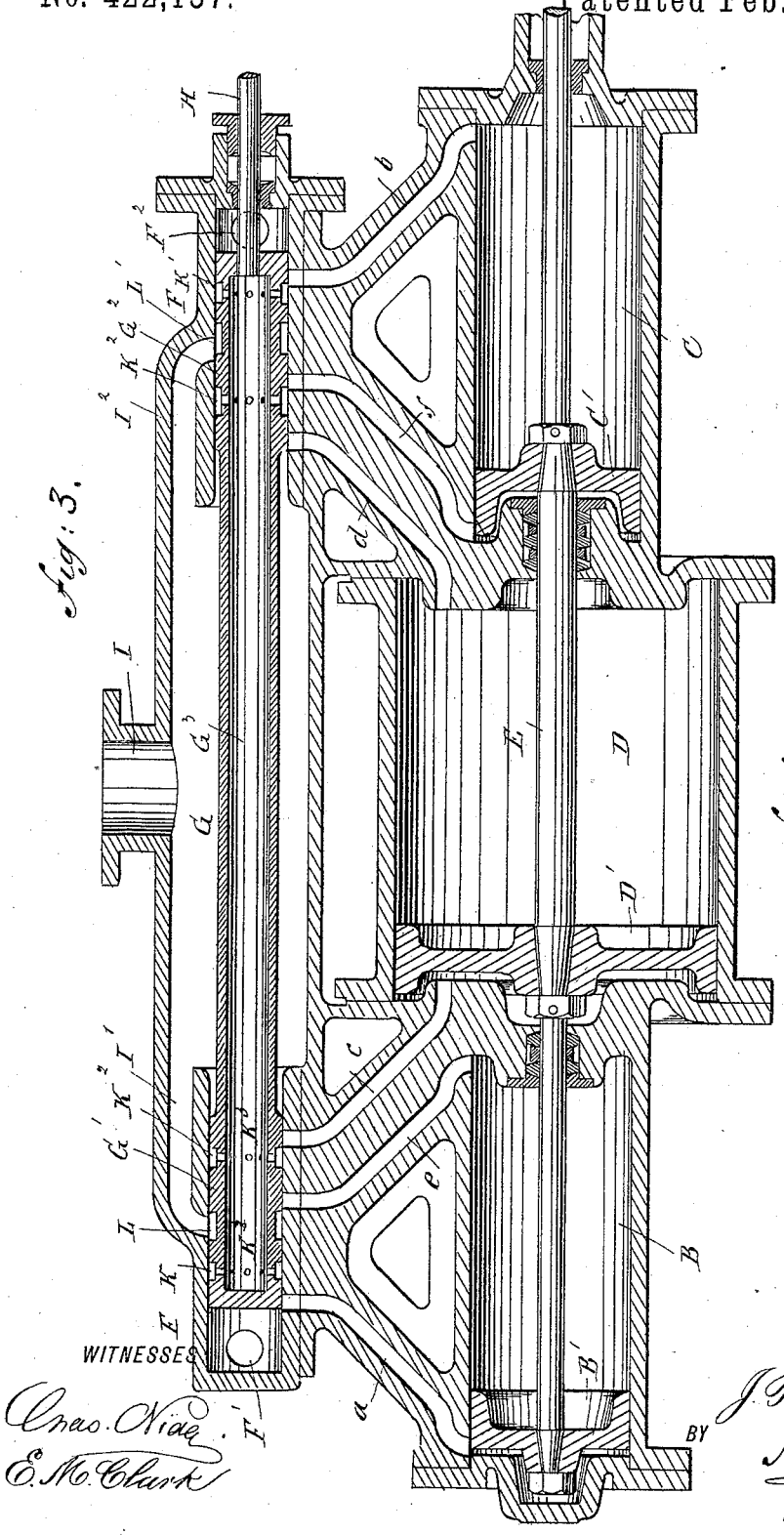
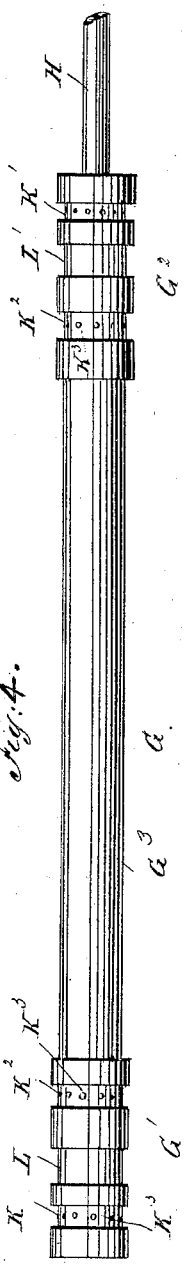


Fig: 4.



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UNITED STATES PATENT OFFICE.

JOHN RIEKIE, OF LAHORE, INDIA.

COMPOUND ENGINE.

SPECIFICATION forming part of Letters Patent No. 422,157, dated February 25, 1890.

Application filed July 1, 1889. Serial No. 316,250. (No model.)

To all whom it may concern:

Be it known that I, JOHN RIEKIE, of Lahore, India, have invented a new and Improved Compound Engine, of which the following is a full, clear, and exact description.

The object of the invention is to provide a new and improved compound engine which is simple and durable in construction and very effective in operation, utilizing the steam to the fullest advantage.

The invention consists in certain parts and details and combinations of the same, as will be fully described hereinafter, and then pointed out in the claims.

Reference is to be had to the accompanying drawings, forming a part of this specification, in which similar letters of reference indicate corresponding parts in all the figures.

Figure 1 is a sectional side elevation of the improvement. Fig. 2 is a transverse section of the same on the line x x of Fig. 1. Fig. 3 is a sectional side elevation of a modified form of the improvement, and Fig. 4 is a side elevation of the valve for the same.

The compound engine A, as illustrated in Figs. 1 and 2, is provided with the two high-pressure cylinders B and C, between which is held a low-pressure cylinder D, all three cylinders being placed in line with each other. In the cylinders B C D are held to slide pistons B′, C′, and D′, respectively, all secured to a piston-rod E, connected in the usual manner with the main driving-shaft of the engine.

Into the inner ends of the high-pressure cylinders B and C lead the live-steam ports a and b, respectively, also opening into the ends of the steam-chest F, preferably of cylindrical form, and containing a hollow cylindrical valve G, connected with the valve-rod H, operated in the usual manner from the main driving-shaft of the engine.

Into the ends of the steam-chest F lead pipes F′ F², connected with the steam-dome of the boiler, so as to supply the said steam-chest with live steam. From the top of the steam-chest and in the middle of the same extends the exhaust-pipe I, provided with two channels I′ and I², leading to the interior of the steam-chest F. The latter is also connected near its middle by the ports c and d with the ends of the low-pressure cylinder D. From the said ports c and d lead the pipes J and J′, respectively connected with the ports e and f, respectively leading to the outer ends of the high-pressure cylinders B and C, respectively.

In the periphery of the cylindrical valve G are arranged annular grooves K, K′, and K², connected by apertures K³ with the interior of the said valve G. Between the annular grooves K and K² is formed an annular groove L, adapted to register with the port c and the branch I′ of the exhaust-pipe I. A similar annular groove L′ is formed in the periphery of the valve G between the annular grooves K′ and K², and the said annular groove L′ serves to connect the port d with the branch I² of the exhaust.

The operation is as follows: When the engine is in the position shown in Fig. 1, the live steam from the boiler passes into the right-hand end of the steam-chest F, and passes from the latter through the port b into the inner end of the high-pressure cylinder C to exert its pressure against the piston C′. The latter is thus forced outward in the direction of the arrow a', carrying the pistons B′ and D′ in the same direction. Any steam in front of the piston C′ passes through the port f into the pipe J′, and from the latter into the port d, from which the exhaust-steam passes into the annular groove L′ and into the exhaust-pipe I. Steam in front of the piston D′ passes through port d and the annular groove L′ into the exhaust-pipe I with the exhaust-steam from the high-pressure cylinder C. The exhaust-steam in front of the piston B′ in the high-pressure cylinder B passes through the port a into the annular groove K, and from the latter through the openings K³ into the interior of the valve G, from which the steam passes through the openings K³ into the annular groove K², and from the latter into the port c, from which it passes to the left-hand end of the piston D′, thus exerting its force against the piston D′ and assisting the live steam acting against the piston C′, as above described, to move the

piston-rod E in the direction of the arrow a'. Part of the exhaust-steam from the cylinder B, which passes into the port c, as above described, passes from the latter through the pipe J and the port e to the left-hand end of the piston B'. When the pistons B', D', and C' are at the ends of their strokes, the valve G is shifted in the usual manner, so that the port b is cut off from the right-hand end of the steam-chest F, while the left-hand end of the latter connects by the port a with the inner end of the high-pressure cylinder B. The live steam from the steam-chest F, passing through the port a into the cylinder B, now exerts its pressure against the piston B' and forces the same with the pistons D' and C' in the inverse direction of the arrow a'. The steam on the left-hand end of the piston B' is now exhausted through the port e, the pipe J, the port c, and the annular groove L into the branch I' of the exhaust-pipe I. The steam on the left-hand end of the piston D' also passes into the port c and passes into the exhaust-pipe I by means of the annular groove L. The steam on the left-hand end of the piston C' passes through the port b into the annular groove K', and from the latter by its openings K^3 into the interior of the valve G. The steam then passes from the interior of the valve G into the annular groove K^2, now connecting with the port d, so that the said steam passes to the right-hand end of the cylinder D and exerts its power against the piston D', assisting in moving the piston-rod E in the inverse direction of the arrow a'.

In the modification illustrated in Figs. 3 and 4 the inlet-ports a and b for the high-pressure cylinders B and C discharge into the said cylinders at their outer ends instead of at their inner ends, as previously described with reference to Fig. 1. The other ports e and f lead from the inner ends of the cylinders B and C and discharge into the steam-chest F, made of two parts, containing the heads G' and G^2 of the valve G, said heads being connected with each other by a hollow stem G^3. From the steam-chest F lead the ports c and d to the ends of the cylinder D. In the head G' of the valve G is formed an annular groove K, operating over the inlet-port a, and permitting the steam to pass into the interior of the valve-heads G' and G^2 and the connecting hollow tube G^3. In the head G' is further formed the annular groove K^2, connected with the interior of the head by the apertures K^3. Said annular groove K^2 operates over the port c. Between the annular grooves K and K^2 is formed an annular groove L, adapted to connect the port e with the channel I' of the exhaust I. The arrangement of the head G^2 of the valve G is similar to that of the head G', previously described. The head G^2 has the annular grooves K' and K^2, and the annular groove L', operating over the ports b, d, and f, and the exhaust-channel I^2. The operation is similar to the one described in reference to Fig. 1, with the exception that the live steam entering the steam-chest F passes through the ports a and b into the outer ends of the cylinders B and C, instead of at the inner ends, as described with reference to Fig. 1.

It will thus be seen that boiler-pressure steam is allowed to do duty for one stroke on the piston in the high-pressure cylinder, after which said cylinder is converted to a steam-chamber on the return-stroke of the piston while the steam is doing a second duty—that is, expanding in another cylinder—and so on until all useful pressure of the steam is used up, and is then allowed to escape to the atmosphere or to a condenser. It will be further seen that double power is exerted by the force of the steam. The cylinders can be greatly reduced in size so as to save considerable steam, at the same time developing a large amount of power. It will further be seen that an equal power is exerted on the crank-arms of the main driving-shaft at all grades of expansion, compounding being done on each crank separately.

In this engine a vacuum is produced on all pistons when the steam is at work on the opposite side.

No waste of steam is possible in this engine, and consequently there is no necessity for spark-arresters when the machine is applied on locomotives. When the engine is started, the valve G is so shifted as to admit steam to the low-pressure cylinder, if deemed necessary.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a compound engine, the combination, with two high-pressure cylinders and a low-pressure cylinder between the said high-pressure cylinders, of a steam-chest provided with a port leading to each high-pressure cylinder and with two ports leading to the low-pressure cylinder, pipes leading from the ports of the low-pressure cylinder to the high-pressure cylinders, and a hollow cylindrical valve provided with annular passages, some of which communicate with the interior of the same, substantially as herein shown and described.

2. In a compound engine, the combination, with two high-pressure cylinders and a low-pressure cylinder, of a steam-chest provided with ports leading to the said cylinders, and the hollow cylindrical valve G, provided with the annular grooves K K' K^2, connected by apertures K^3 with the interior of the valve, and the intermediate annular grooves L L', substantially as herein shown and described.

3. In a compound engine, the combination, with two high-pressure cylinders and a low-pressure cylinder, of a steam-chest provided with a port leading to each high-pressure cylinder and with two ports leading to the low-pressure cylinder, pipes connecting the

passages leading from the steam-chest to the low-pressure cylinder with the high-pressure cylinders, and the hollow cylindrical valve G, provided with the annular grooves K K′ K^2, connected by apertures K^3 with the interior of the valve, and the annular grooves L L′ between the grooves K and K^2 and K^2 and K′, respectively, substantially as described.

JOHN RIEKIE.

Witnesses:
A. KEENE,
C. A. SYKES.